IN VITRO KINEMATICS OF UNICONDYLAR KNEE ARTHROPLASTY

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Introduction

It is assumed that unicondylar knee arthroplasty (UKA) features kinematics closer to the natural knee than total knee arthroplasty [Laurencin, 1991]. Clinical studies have also shown functional benefits for UKA. There is to date only little biomechanical data to support or explain these findings. In this project, knee kinematics before and after medial UKA were analyzed and compared during an in vitro simulation with cadaveric specimens.

Materials and Methods

Six fresh frozen full leg cadaver specimens were mounted in a kinematic rig with six degrees of freedom for the knee joint [Victor, 2009]. Three motion patterns were applied before and after medial UKA (Accuris, Smith & Nephew, TN): passive flexion-extension, open chain extension, and squatting. During loaded motions, quadriceps and hamstrings muscle forces were applied. Infrared cameras continuously recorded trajectories of markers rigidly attached to the femur and tibia. Prior computer tomography allowed identifying coordinate frames of the bones and calculations of anatomical rotations and translations.

Results

Native kinematics was reproduced after UKA in all the specimens. In the unloaded knee and during open chain extension, femoral rollback patterns after UKA were very close to those in the native knee (Figure 1). During squatting, the medial femoral condyle after UKA tended to be more posteriorly and superiorly with flexion and there was less tibial internal rotation (Figure 2). The tibia was found to be in more valgus after UKA during all motion patterns.

Discussion and conclusion

As ligaments, lateral compartment and patellofemoral anatomy are preserved with UKA, unloaded it closely resembles native knee kinematics. The slight kinematic changes that were found during loaded motion are probably due to loss of the conforming medial meniscus and to the mismatch in geometry and stiffness introduced by UKA.

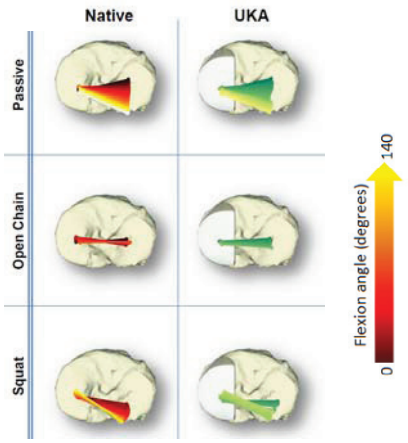

Figure 1: Femoral rollback patterns before and after UKA for a typical specimen tested in passive, open chain and squatting motion.

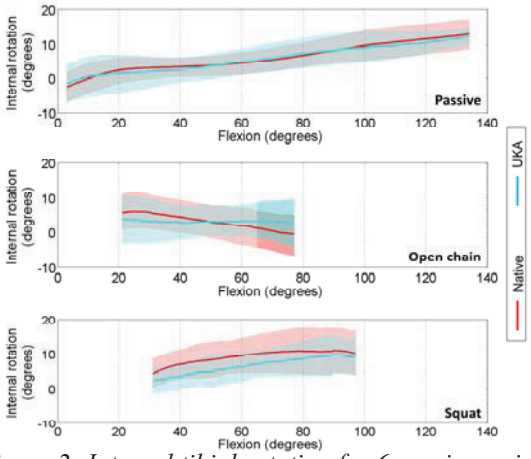

Figure 2: Internal tibial rotation for 6 specimens in passive, open chain and squatting motions before and after UKA. Standard deviations are shown in shaded areas, with highlighted regions showing significant differences ($p<0.05$).

This in vitro setup shows that UKA allows for reproducible restoration of kinematics that are close to the native knee, particularly in the unloaded situation. Following UKA, loaded kinematic patterns resemble those found in knees with significant loss of function of the medial meniscus.

References

Laurencin, et al, Clin Orth Rel Res, 151-156, 1991.
Victor *et al*, JBJS (Am), 91(6) 150-163, 2009.